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**The use of ground penetrating radar to map soil
physical properties that control water flow
pathways in alluvial soils**

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Abstract

Soil drainage models are vital for informing smart agricultural practices. Predicting soil drainage and zones where denitrification occurs, requires knowledge of the spatially varying subsurface features, for example soil-thickness, flow pathways, and depth to water table. Obtaining information about these features rapidly and non-invasively requires the use of geophysical techniques such as ground penetrating radar (GPR). While applications of GPR are diverse, ranging from geotechnical to archaeological investigations, to mineral and groundwater exploration, GPR has not been extensively applied in soil mapping for agricultural purposes across alluvial soils. The potential use of GPR for identifying subsurface features, such as the depth to gravel and water table which both influence soil drainage and denitrification processes, could benefit future developments in precision agriculture. To assess applicability of GPR for this purpose, this thesis presents research conducted on the alluvial soils at Dairy 1 farm, Massey University, Palmerston North. Radargrams were collected on two 0.4 ha plots, one arable and one pasture, using 200 MHz and 100 MHz antennas, in a 2-m grid pattern. Radargrams were ground-truthed with 13 soil cores and 21 auger holes, targeting different layers detected by GPR. The soil cores were analysed for bulk density, soil moisture and particle size. Using the 200 MHz antennas, soil textural banding was identified with specific reflection configurations within individual radargrams. These were represented when a contrasting textural boundary appeared as a continuous line of two to three bands. However, finer layering features were not identified. The 100 MHz antennas were able to detect depth to water table in the pasture plot. Soil moisture conditions were identified by a change in radar wave velocity. This appeared on radargrams as a difference in depth and radargram configuration shape. The use of Slice View images compiled from radargram data, assisted with identifying potential flow pathways and the depth to the water table across the pasture plot. Validation of radargrams with soil core samples indicates that GPR can obtain meaningful results from alluvial sediments ranging from sandy loams to silt loams. The use of GPR for

delineating subsurface features in alluvial soils is a promising tool that could assist with precision agricultural practices.

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